Electrodeposited Cd and Pb Schottky Junctions on CH_3-Terminated n-Si(111) Surfaces

Electrodeposition has been widely used to form metal/semiconductor contacts and to deposit metal-catalyst islands onto semiconductor photoelectrodes. Among the interesting features of this approach are that the process can be monitored *in situ* and that real-time information on the energetics and physical state of the semiconductor surface can be obtained. Maldonado and Lewis from the California Institute of Technology recently reported the electrodeposition of Cd and Pb films onto H- and CH_3-terminated n-Si(111) surfaces. Since these metals do not readily form silicides, they are well-suited to studying whether electrodeposited metal contacts yield the expected variation in barrier height as the surface is changed by alkylation. The authors used voltammetry, chronoamperometry, x-ray photoelectron spectroscopy, and electrical measurements on Schottky junction devices to demonstrate that the equilibrium junction barrier height at the Si/solution and Si/metal junctions were small, that the barrier height for contacts on nondegenerately doped n- type CH_3- Si(111) was large, and that much larger barrier height values were obtained on CH_3-terminated n-Si(111) surfaces than on H-terminated n-Si(111) surfaces. Their results complement earlier studies on CH_3-terminated Si(111) and further demonstrate the durable, well-defined, and unique properties of interfaces formed on these surfaces that make them attractive for metal contact formation.

From: J. Electrochem. Soc., ***156****, H123 (2009).*

Aging Model for Li-Ion Battery Life Prediction in Multiple Operation Modes

Lithium ion batteries are being utilized as power sources in an increasing number of long-life applications. Aging models can aid prediction of the feasibility of a cell design or chemistry for use in these applications. The models that exist in the literature have focused exclusively on single modes of aging (*i.e.*, aging during open-circuit voltage (OCV) storage, constant-voltage storage, or charge/discharge cycling). Researchers in France simulated aging for these three operational modes using a physics-based phenomenological model of the solid electrolyte interphase (SEI) growth on carbonaceous anode active particles and compared their results to experimental $LiCoO_2$/Graphite 18650 cell data found in the literature. Their model considered SEI growth from both solvent decomposition kinetics and solvent diffusion through the SEI layer. Through parameter refinement during cycling mode simulations, the authors satisfied their capacity fade and SEI resistance increase objectives for both kinetically-limited and diffusion-limited cases. Applying the cycling mode aging parameters to constant-voltage and OCV storage mode simulations revealed that the diffusion-limited case was much better correlated to the irreversible capacity loss data than was the kinetically-limited case, suggesting that SEI growth is a diffusion-limited process and that a universal set of parameters may describe multimodal aging.

From: J. Electrochem. Soc., ***156****, A145 (2009).*

Low-Temperature Synthesis of $LiFePO_4$

Despite the drawback of having a lower energy density, $LiFePO_4$ enjoys attention as a Li-ion battery cathode material, in part due to its composition of lower cost and more environmentally friendly elements. Various synthesis routes have been investigated for the anticipated large-scale need by electric vehicle markets. Inspired by the low-temperature synthesis of diverse inorganic compounds via the temperature-driven decomposition of urea, researchers from France investigated the use of nitrogen-containing molecules as "latent bases" in a solvothermal process of making $LiFePO_4$ powders. Using these "latent base" additives, instead of LiOH, permits the controlled formation of the basic species needed for raising the pH of the LiH_2PO_4 solution and precipitating the iron phosphate. The authors learned details about the reaction path by sampling intermittent aliquots during the reaction in the autoclave. They measured the solution pH and used X-ray powder diffraction patterns to identify the phases formed. Among the suite of solvent/latent base/temperature parameters available, the use of dimethylformamide led to the formation of a polymeric layer coating the particles. Upon flash annealing at 680°C in an argon environment, this polymeric layer was transformed to carbon, thereby providing a simple synthesis route for carbon-coated $LiFePO_4$ particles.

From: Electrochem. Solid-State Lett., ***12****, A39 (2009).*

Hydrothermal Synthesis and Characterization of Undoped and Eu-Doped $ZnGa_2O_4$ Nanoparticles

Innovations in the synthesis of multicolor, nanoscale phosphors for video display devices have focused on low-temperature, low-cost techniques that yield highly monodisperse materials in a variety of wavelength ranges. Many of the phosphors that achieve this broad color tunability employ rare earth ions (RE^{2+} and RE^{3+}) as dopants, taking advantage of the stable, characteristic phosphorescence that arises from these materials. Bulk zinc gallium oxide ($ZnGa_2O_4$) based materials have been widely employed in a variety of flat panel display systems as high-quality, blue-emitting phosphors. However, rare earth-doped forms of $ZnGa_2O_4$ have not been extensively investigated. Scientists from the Optoelectronic Devices Laboratory of the Cochin University of Science and Technology have developed a hydrothermal synthesis of nanoparticulate forms of undoped and europium-doped $ZnGa_2O_4$. The doped version of these nanoparticles exhibit the strong $^5D_j \rightarrow {}^7F_{j'}$ luminescence transitions for which Eu^{3+} is well known. As well, this direct bandgap material, 4.52 eV in bulk but 4.59 eV in nanoparticulate form, exhibits size-dependent, quantum confinement effects. Interestingly, the undoped nanoparticles exhibit an unexpectedly broad luminescence spectrum in the visible, markedly broader than its bulk counterpart. Furthermore, the photoluminescence spectra for their discussed 6-9 nm $ZnGa_2O_4$ nanoparticles are only nominally blueshifted compared to the bulk spectrum. Additional investigation of smaller nanoparticle sizes and with different RE^{3+} dopants may shed light on avenues to employ undoped and doped $ZnGa_2O_4$ in a broader range of video display and solid-state lighting applications.

From: J. Electrochem. Soc., ***156****, K33 (2009).*

Characterization of the Conduction Mechanisms in Adsorbed Electrolyte Layers on Electronic Boards Using AC Impedance

The impact of solder flux residue on electronic assemblies is traditionally evaluated via surface insulation resistance (SIR) measurements. In this paper, an AC impedance technique has been investigated in an effort to provide more detailed information on the conduction mechanisms and electrode reactions in the presence of such residue. AC impedance measurements can distinguish between the ionic resistance of adsorbed electrolyte films as found on printed circuit boards and the impedance attributed to electrochemical processes, such as corrosion and/or dendrite formation, at the electrodes. Under conditions where dendrites are observed to form under the application of the DC voltage used to acquire SIR measurements, AC impedance measurements did not result in dendrite formation, but did provide a response with features consistent with the addition of electrochemical processes. Under conditions of low flux-residue levels, where no dendrites form during the application of a DC potential, the AC impedance results were equivalent to the traditional SIR measurement. While the AC impedance technique does take longer to perform than the DC measurements, the ability of the approach to access the electrode reactions and predict dendrite formation suggests that this may be an effective non-destructive evaluation technique.

From: J. Electrochem. Soc., ***156****, C8 (2009).*

Tech Highlights was prepared by David Enos and Mike Kelly of Sandia National Laboratories, Craig Walker of Valence Technology, Inc., James Dickerson of Vanderbilt University, and Donald Pile. Each article highlighted here is available free online. Go to the online version of Tech Highlights, in each issue of Interface*, and click on the article summary to take you to the full-text version of the article.*